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ABSTRACT

This self-paced student training module on hand electric tools is one of a number of modules developed for Pre-apprenticeship Phase 1 Training. Purpose of the module is to teach students the general uses and precautions of common portable electric tools. The module may contain some or all of the following: a cover sheet listing module title, goal, and performance indicator; study guide/checklist with directions for module completion; introduction; information sheets providing information and graphics covering the module topic(s); self-assessment; self-assessment answers; post assessment; and post-assessment answers. (YLB)

INDIVIDUALIZED LEARNING SYSTEMS

PRE-APPRENTICESHIP PHASE 1 TRAINING

HAND ELECTRIC TOOLS

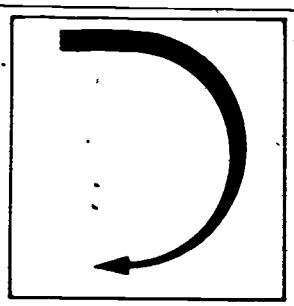
Goal:

The student will learn the general uses and precautions of common portable electric tools.

Performance Indicators:

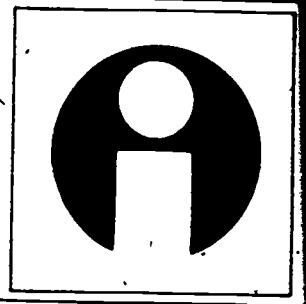
The student will demonstrate an understanding of the subject by successfully completing a Self Self Assessment and a Post Assessment exam.

Introduction



Without power tools of many kinds, today's skilled worker could not produce work of the quality and quantity currently demanded in technical occupations. Not too many years ago, the only portable electric tool regularly found on the job was the electric drill. Today, portable electric tools of many kinds are available, and the apprentice is expected to learn early in his career how to operate all such tools used in his trade. This module describes some of the most common portable electric tools and gives information needed for their effective and safe use.

Study Guide



To successfully complete this module, complete the following tasks in the order listed. Check each one off as you complete it.

1. ____ Read the Goal and Performance Indicators on the cover of this module. This will inform you of what you are expected to gain from completing this module and how you will demonstrate that knowledge. Read the Introduction section to understand why this module is important.

2. ____ Study the Information section of this module to acquire the knowledge necessary to complete the Self and Post Assessment exams.

3. ____ Complete the Self Assessment exam and compare your answers with those on the Self Assessment Answer Sheet on the page immediately following the exam. Re-study or ask your instructor for help on any questions you have trouble with. The Self Assessment exam will help you determine how well you are likely to do on the Post Assessment.

4. ____ Complete the Post Assessment exam and turn your answers in to your instructor. It is recommended that you score 90% or better on the Post Assessment before going on to the next module.

Information

PORTABLE ELECTRIC DRILLS

The portable electric drill is the most versatile and probably the most often used power hand tool. (See Fig. E-49.) The more powerful tools of this type can be used not only to drill holes but also--with special bits and attachments--to sand, polish, countersink, grind, hammer, stir nonflammable paint, and drive screws. With other attachements, the drill can be converted to a circular saw, a jigsaw or a table saw, but such conversions are more popular with the hobbyist than with the production-minded industrial user; the latter will generally prefer to use a power tool specifically designed for the job at hand.

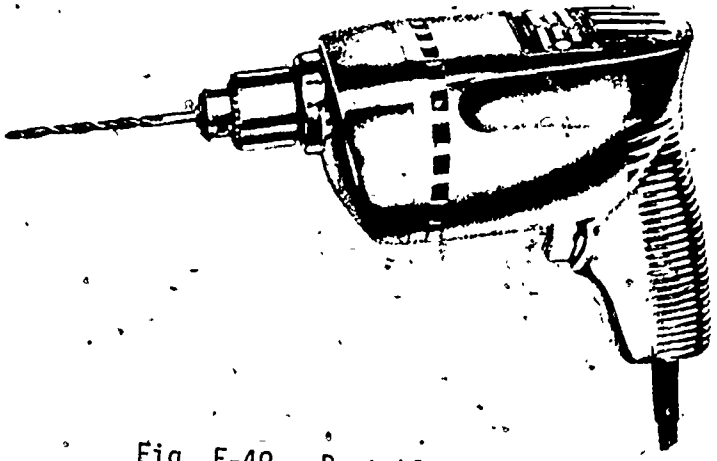


Fig. E-49. Portable electric drill

The 1/4 in. electric drill is generally a high speed tool intended for relatively light-duty applications; the more powerful but lower-speed 3/8 in. and 1/2 in. drills are used for heavier jobs. The chuck speed specified by the power-tool manufacturer is generally the "no-load" or free-running speed. The drill speed will slow down considerably during the drilling operation. If the job calls for heavy work, an electric drill must be selected that has enough power to turn the chuck at the desired speed without overloading (and thus overheating) the motor.

A cordless drill that requires no power connection is available; its power source is a self-contained, rechargeable battery. Unlike other portable electric tools, the cordless drill need not be grounded for safety. This power tool has obvious advantages for working on roofs, in wet locations, or in other places where it is difficult or dangerous to run the cords of conventional electric drills.

PORTABLE ELECTRIC SAWS

Hand-operated saws still have many uses in the skilled trades; however, portable electric saws, because of their versatility and high production capability, have become the preferred types, particularly in the construction industry. The most widely used portable electric saws are probably the electric handsaw and the sabre saw.

THE ELECTRIC HANDSAW

Electric handsaws (portable electric circular saws) are made in sizes to accomodate saw blades ranging in diameter from about 6 in. to about 9 in. The greater the blade diameter, the greater the maximum depth of cut of the saw. A saw with a 6 1/2 in. blade will make a cut about 2-3/32 in. deep; a 7-1/4 in. saw, a cut about 2-7/16 in. deep. (See Fig. E-50.)

FEATURES OF ELECTRIC HANDSAWS. Electric handsaws are used primarily for cross-cutting and ripping wood, standard models being equipped with a combination wood-cutting blade. Special types of blades are available for cutting nonferrous metals and ceramics. The base of the saw may be raised or lowered to control the depth of the cut, and most saws will make a bevel cut up to 45°. The blade rotates counter-clockwise and cuts in the upward direction. The upper half of the blade is shielded by a fixed guard; the lower half is shielded by a hinged or telescoping guard that opens as the blade is presented to the work and automatically closes over the blade when the cut is completed.

SAFETY AND THE ELECTRIC HANDSAW.

If improperly used, the electric handsaw can be the most dangerous of all portable electric tools. General instructions for the grounding and safe operation of all portable electric tools, including saws, are given elsewhere in this topic; however, every mechanic should also observe the following special safety rules whenever the need arises for using an electric handsaw:

- Before connecting the saw to the power source, be sure the saw blade is tight on

the arbor, all guards are in place and in good working order, and all adjusting devices for depth and angle of cut are securely tightened at the desired settings. Never make adjustments to the saw without first disconnecting the power cord from the outlet.

- Inspect the work before beginning the cut to avoid cutting into nails or other dangerous obstructions.
- Never reach underneath the material being cut.
- Stand to one side of the cut.
- As soon as the cut is completed, release the switch. Wait until the blade stops turning before setting the saw down.

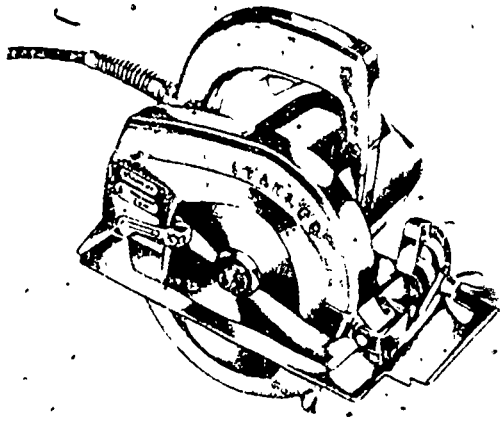


Fig. E-50. Electric handsaw

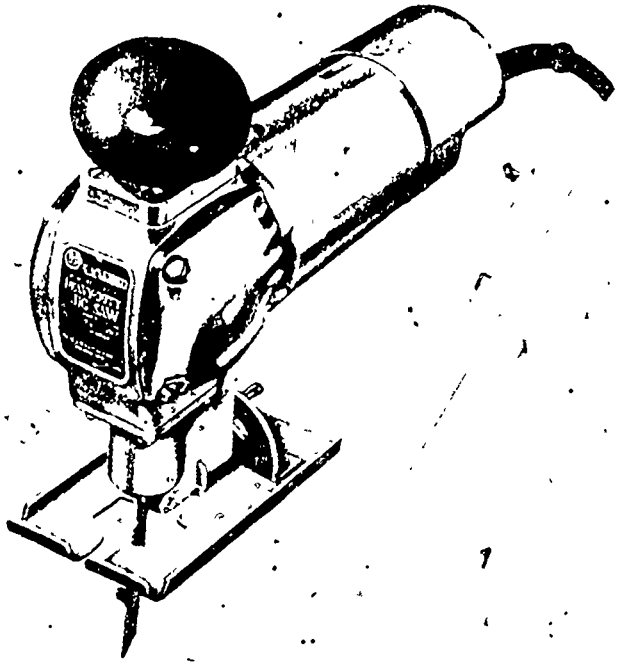


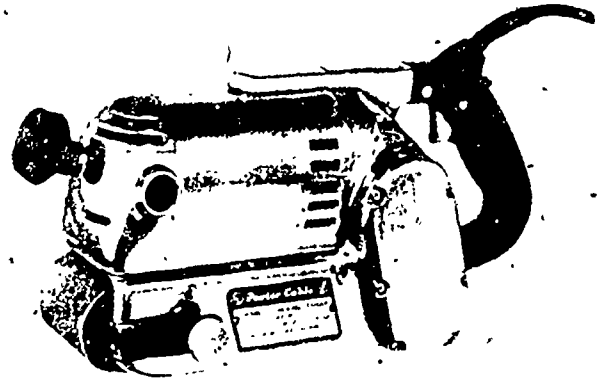
Fig. E-51. Sabre saw

THE SABRE SAW

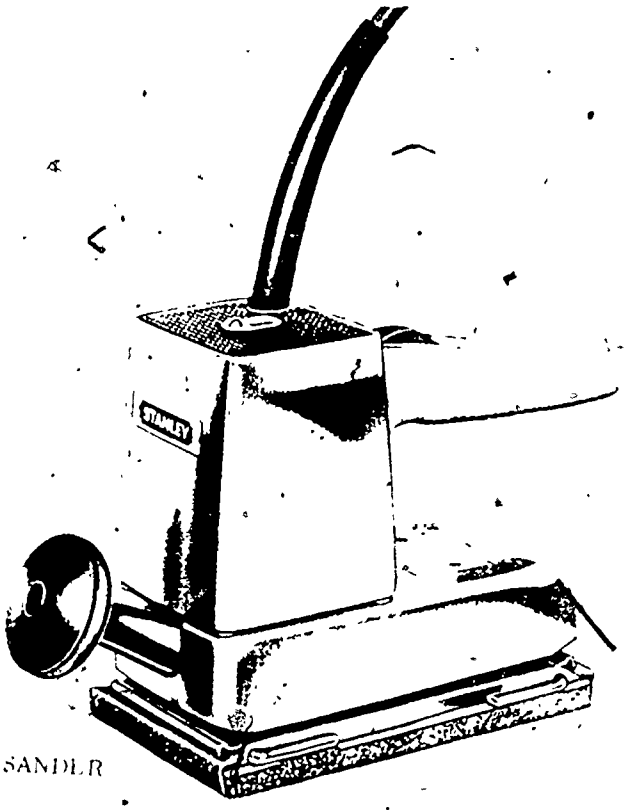
The sabre saw is a reciprocating-blade saw; its blade moves up and down in cutting. (See Fig. E-51.) The blade has a stroke of about 1 in., and its tip is pointed and sharp so that it can start its own hold. Right- or left-hand bevel cuts, sharp angles and curved cuts are practicable with this power tool. Special saw blades are available for cutting materials other than wood. The average cutting speed of sabre saws is about 3,800 strokes per minute.

PORTABLE ELECTRIC SANDERS

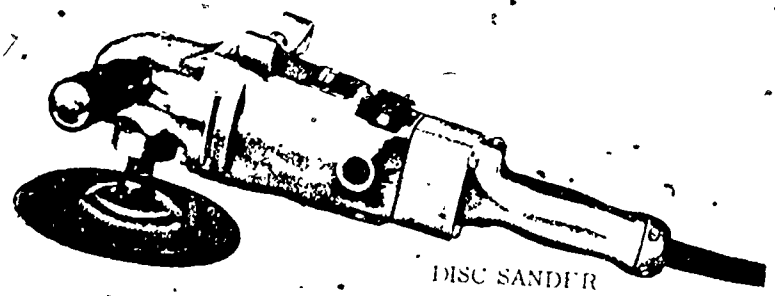
Three types of portable electric sanders are in wide use: the belt sander, the orbital sander and the disc sander. (See Fig. E-52.) These power tools range in weight from about 6 pounds to about 30 pounds; the weight of the tool can therefore be a consideration if the worker must support it for a long period in an awkward position. Some types of power sanders are equipped with a bag for collecting the dust produced during operation. This can be a desirable feature, especially if the sander is to be used for prolonged periods; it is unpleasant and even unhealthful to breath the dust resulting from the sanding operation.



BELT SANDER



ORBITAL OR FINISHING SANDER



DISC SANDER

Fig. E-52. Portable electric sanders

THE BELT SANDER

The belt sander is most useful for sanding large, flat areas. The sanding is done in a straight line by a continuous belt that runs over a base plate at high speed. When used on wood, the sander should be directed with the grain. Belts are available in several abrasive grades for rough to fine sanding of wood, and special belts are available for materials other than wood. Belt sanders are sized by the width and length of the belt.

THE ORBITAL SANDER

The orbital or finishing sander has a rectangular, padded base plate to which a piece of abrasive paper or cloth is attached by means of clamps. The rotary motor of the tool is geared to move the base plate rapidly in a limited circular orbit, and the plate oscillates--moves back and forth and from side to side--thousands of times per minute as its sands. The orbital sander can therefore be operated either with or against the grain, and it can be used in small spaces and corners. It is most useful for finish work.

THE DISC SANDER

The flexibility of its rotary sanding disc makes the portable electric disc sander better suited for sanding uneven or curved surfaces than a straight-line sander. The disc is removable and can be replaced with attachments for wire brushing, polishing, buffing and even drilling.

GROUNDING PORTABLE ELECTRIC TOOLS

Safety requires that portable electric tools must be grounded when in use unless they are of the cordless (battery-operated) type. An electrical system or appliance is grounded when those metal parts of it that are not intended to carry current--the frame and the housing, for instance--are connected to the earth through some conductive material, normally a grounding wire. The purpose of the grounding conductor is to carry electric current harmlessly away if it should "leak" to the metal case of the appliance or tool. Such leaks, which are called fault currents, result from breakdown of the insulation of the conductors within the tool. When a live, uninsulated conductor "shorts" to the frame or case of a power tool that is not properly grounded, the exposed metal parts of the tool also become live. The tool thus presents a serious shock hazard to the user, who risks being badly burned or even killed as a result of a heavy fault current flowing from the defective tool through his or her body to the earth. A correctly grounded power

tool gives the user his or her best protection against the hazard of severe or even fatal electric shock.

The shorting of live conductors with defective insulation to frames, housing and other normally neutral metal parts can occur in any electrical system or device, but this defect is most likely to occur in portable equipment, which is often subjected to hard use under adverse conditions. The felxible power cords of portable electric tools are particularly vulnerable to damage. Misuse or abuse of a power tool or its cord can also add to the probability of early electrical failure and resulting shock hazard.

THE GROUNDING CONNECTION

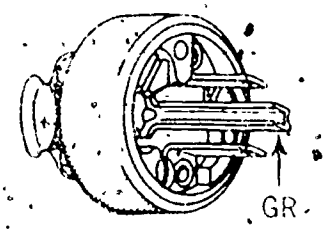
To be effective, the grounding connection must be continuous from the housing or frame of the tool through the tool's power cord and plug to the outlet box, and thence through the wiring system to a metal pole or water pipe buried in the earth. In other words, whenever a connection is made between any of the component parts of a grounded electrical system--say an electric drill and an extension cord or the extension cord and the service outlet--the grounding wire of each unit in the system must be connected to the grounding wire of the next unit.

GROUNDING CAPS

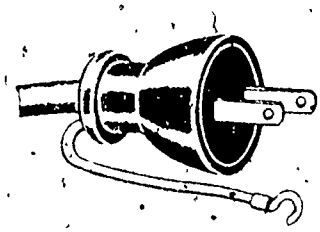
Every new portable electric tool is equipped with a power cord having an extra conductor that serves as a grounding wire, and the cord is terminated with a three-prong grounding cap or plug. The two shorter blades of the cap carry the current. The longer blade serves as the grounding contact; it is connected to the grounding conductor in the power cord. The grounding blade is made longer than the current-carrying blades so that it will be the first to make contact when the cap is being plugged into the receptacle and the last to break contact when the cap is being withdrawn. (See Fig. E-53.)

Many residences and workshops are not equipped with outlets designed for three-prong grounding caps; instead, they have the familiar two-slot receptacles. Adapters are available to permit use of the three-prong grounding cap in a two-slot outlet. Older power tools commonly were equipped with a two-prong adapter cap with a "pigtail" grounding wire like the one illustrated in Fig. E-53. The user is expected to fasten the pigtail connector to the screw in the center of the plate covering the outlet box, but this requirement is often neglected. Even if

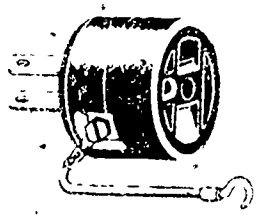
the user remembers to fasten the pigtail to the plate screw, there is no assurance that the appliance will be correctly grounded unless it is known that the house wiring system is correctly grounded. In addition, this old-fashioned adapter cap introduces a new hazard: if the loose pigtail gets caught between the cap and the receptacle and touches the "live" blade of the cap, the entire housing of the tool will then be live and can then give anyone who touches it a severe or even lethal shock. This type of cap is now banned by National Electrical Code and should be replaced by an approved three-prong grounding cap.



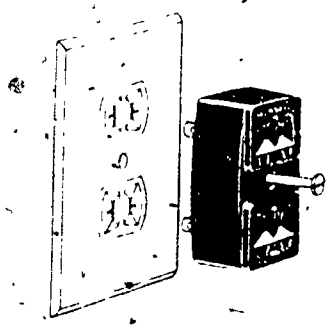
THE THREE-PRONG GROUNDING CAP
THE GROUNDING PRONG GROUNDS
THE FRAME OF THE TOOL



ADAPTER GROUNDING CAP WITH PIGTAIL WIRE
SHOULD BE REPLACED WITH THREE-PRONG CAP



ADAPTER PLUG WITH PIGTAIL WIRE
NOT CONSIDERED A SAFE SUBSTITUTE
FOR A THREE-PRONG GROUNDING PLUG.



SCREW ON ADAPTER SAFE IF THE
ELECTRICAL SYSTEM IS GROUNDED

Fig. E-53. Grounding caps and adapters

Another type of grounding adapter, the adapter plug with pigtail shown in Fig. E-53, is somewhat safer than the adapter grounding cap because it can be properly attached to the outlet before the power tool is plugged in. However, the same objections can be made to it: it will not ground the appliance if the house wiring system is not correctly grounded and the pigtail might make accidental contact with a live prong.

Still another grounding adapter has a long center screw that replaces the plate screw in the outlet. (See Fig. E-53.) This adapter should provide a safe ground connection if the house wiring system is correctly grounded. If the wiring system

is known or suspected to be ungrounded, a separate wire must be run from the grounding terminal on the adapter to a water pipe.

The use of a grounding adapter of any kind can only be justified on the basis of convenience. For safety's sake, correctly grounded receptacles designed for three-prong grounding caps should be installed in place of the old two-slot receptacles by a competent electrician, who should also be called upon to install three-prong caps on power tools that do not have them. The grounding prong should never under any circumstances be cut off a three-prong cap for the convenience of the moment.

EXTENSION CORDS

Extension cords used with portable electric tools must include a grounding conductor and grounding-type caps and connectors. All conductors must be of adequately heavy gage wire. The required wire gage depends upon the length of the extension cord and the current demand of the power tools with which it is to be used; the greater the cord length and current demand, the heavier the conductor. Extension cords should never be used as voltages beyond their specified maximum. Cords should have molded-on caps and connectors of the "unbreakable" type to preclude any possibility of mistakes in their wiring. Only a competent electrican should be permitted to make up an extension cord on the job or repair existing cords or connectors; if a wire were to be improperly connected in an extension cord, a very dangerous shock hazard could result.

PREVENTING ELECTRICAL OVERLOADS

Correct receptacles and plugs, correctly installed, serve not only to ground electrical equipment but also to prevent equipment rated for one voltage from being connected to a circuit of a different voltage. To ensure against damage to equipment resulting from incorrect line voltage, the current-carrying blades of caps on power cords of equipment rated for 125-volt service are so designed that they cannot be plugged into the slots of 250-volt receptacles, connector bodies or motor bases. (See Fig. E-54.) Also, cord caps for equipment drawing 20 amperes will not fit the slot of grounding receptacles rated for 15-ampere service, and so on.

Old-style T-slot receptacles that accept caps with either parallel or tandem blades may still be encountered in some locations. (See Fig. E-55.) These are now out-

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Old-style T-slot receptacles that accept caps with either parallel or tandem blades may still be encountered in some locations. (See Fig. E-55.) These are now out-

lawed and should be replaced by modern receptacles that have grounding terminals and are keyed to prevent equipment from being plugged into the wrong circuit.

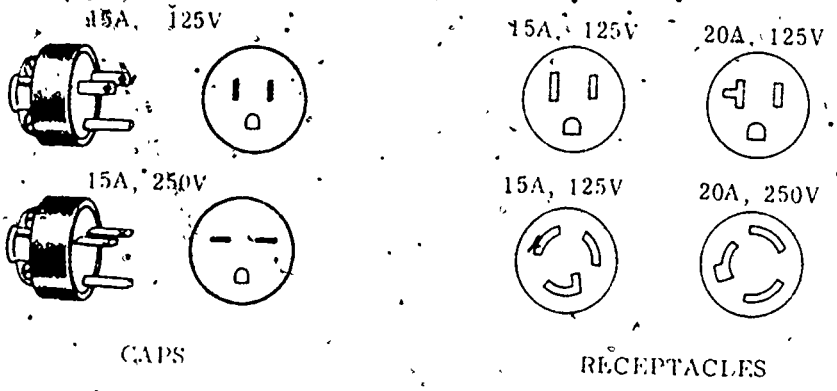


Fig. E-54. Some cap and receptacle types

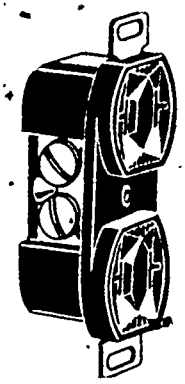


Fig. E-55. T-slot receptacle (now outlawed)

SAFETY WITH PORTABLE ELECTRIC TOOLS

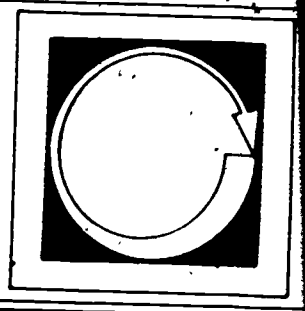
Portable electric tools can be dangerous in the hands of operators who are careless or inadequately trained in their use. Every apprentice should faithfully observe the following safety rules when operating such tools:

- Keep your mind on your work; avoid distractions.
- Be sure that line-powered tools are grounded.
- Keep a firm grip on the tool to retain control if it should catch in the work.
- Be especially careful in wet locations, and never use electric tools where flammable gases or vapors are present. Never use an electric drill to stir paint containing flammable solvents or thinners.
- When you are not using the tool, disconnect it from the power supply.
- Handle power tools with care; sharp blades, bits and other moving parts revolving at great speed can inflict serious injury.
- Arrange power cords so that they will not become fouled in the working parts of the tool. Keep cords away from oil, chemicals and hot surfaces, and never hang them over nails or sharp-edged objects. Never leave cords lying where they might be run over or otherwise damaged or where they could present a stumbling hazard. Store power tools in a clean, dry place with the cords loosely coiled

to protect the cord insulation.

- Never wear loose clothing when operating a portable electric tool or any other power machine.
- Wear safety goggles whenever the use of the power tool could result in the slightest danger to the eyes.

Self Assessment



Read each statement and decide whether it is true or false. Write T if the statement is true; write F if the statement is false.

1. ____ Portable electric drills are sized by the diameter of the largest drill that will fit the chuck.
2. ____ The rates speed of a portable electric drill is the speed in revolutions per minute when drilling metal.
3. ____ The cordless electric drill offers a safety advantage for work in very wet locations.
4. ____ A portable circular saw can be used with a special blade to cut non-ferrous metals.
5. ____ A portable circular saw cannot be used for making bevel cuts.
6. ____ A receiprocating saw blade is one that moves up and down.
7. ____ The sabre saw is designed for cutting wood only.
8. ____ A belt sander can be used only for rough sanding.
9. ____ A belt sander is a straight-line sander.
10. ____ The disc of a disc sander oscillates at high speed.
11. ____ A portable electric drill with a self-contained power source need not be grounded.
12. ____ The parts of a portable electric tool that must be grounded are those metallic components that are not intended to carry current.
13. ____ The correct power cord for use with a grounding cap is one having an extra conductor in addition to the current-carrying conductors.
14. ____ A grounding adapter is an adequate permanent substitute for a wired-in grounding receptacle.

SELF ASSESSMENT ANSWER SHEET

1. T
2. F
3. T
4. T
5. F
6. T
7. F
8. F
9. T
10. F
11. T
12. T
13. T
14. F

Post Assessment

Listed below each numbered item are four possible answers or completing phrases. Decide which of the four is correct, or most nearly correct; then write the corresponding letter in the blank at the right of that item.

1. ___ The size of a portable electric drill is determined by the tools':
   a. horsepower
   b. voltage rating
   c. chuck capacity
   d. weight

2. ___ The maximum depth of cut of a portable electric circular saw is determined by the:
   a. blade diameter
   b. direction of blade rotation
   c. motor size
   d. type of wood to be cut

3. ___ The portable electric tool best suited for cutting a large hole in a sheet of plywood is a(n):
   a. circular saw
   b. sabre saw
   c. rotary-blade saw
   d. electric drill

4. ___ An electrical tool is grounded if:
   a. it is connected to a receptacle supplying the correct voltage for the tool
   b. its noncurrent-carrying metal parts are electrically connected to the earth
   c. the nameplate of the tool includes the phrase "factory grounded appliance"
   d. the blades of the plug are parallel

5. ___ If a portable electric tool with a three-prong grounding cap must be connected to an old-style two-slot receptacle, the worker should:
   a. cut off the grounding pin
   b. install a new receptacle
   c. install a new cap
   d. use a correctly grounded adapter

6. ____ The portable electric sander best suited for sanding curved surfaces is a(n):

a. orbital sander
b. belt sander
c. disc sander
d. straight-line sander

7. ____ An ungrounded portable electric tool is dangerous to use unless it is:

a. the cordless type
b. used only in dry work areas
c. used only where no flammable gases are present
d. designed for 230-volt operation

8. ____ A 1/4 in. portable electric drill normally takes twist drills of what diameter?

a. 1/4 in. only
b. up to 1/4 in.
c. 1/8 in. to 1/4 in.
d. 1/4 in. to 3/8 in.

9. ____ The manufacturer's specified chuck speed for an electric drill is generally the:

a. no-load speed
b. half-load speed
c. normal-load speed
d. full-load speed

10. ____ Which one of the following must be done before any parts replacements or adjustments are attempted on a portable electric tool?

a. The tool must be cleaned.
b. The power cord must be unplugged.
c. The foreman must be notified.
d. The switch on the tool must be off.